

IDENTIFYING IMPORTANT AREAS FOR BIRD CONSERVATION  
IN THE WESTERN GHATS REGION OF MAHARASHTRA, INDIAPRACHI MEHTA<sup>1,2</sup> AND JAYANT KULKARNI<sup>1,3</sup><sup>1</sup>Wildlife Research and Conservation Society, 1A Shriyog Housing Society, 127/3 Sus Road, Pashan, Pune 411 021, Maharashtra, India.<sup>2</sup>Email: prachimehta1@gmail.com<sup>3</sup>Email: kulkarni.jayant@gmail.com

Despite holding vital habitats and biodiversity that call for conservation measures, the Western Ghats region in Maharashtra are facing severe threats due to loss of forested area. We carried out a survey of birds of this area from 2007 to 2009 to enumerate species richness and assess the distributional status of birds of the region, with focus on eight endemic bird species in seven Protected Areas (PAs) and 11 Reserve Forests (RFs) to identify the areas that are important for long-term conservation of birds in the region. Bird species richness was highest in the PAs of Chandoli and Phansad and in the RFs of Sawantwadi, Lonavala, and Amba. The number of endemic species was highest in the protected areas of Chandoli, Koyna, and Radhanagari, and in the reserve forests of Lonavala, Chandgad, Sawantwadi, Amba, and Amboli. Prioritisation of areas was done based on bird species richness, presence of endemic and threatened birds, and threat levels. Based on the results of the survey, we suggest declaration of Chandoli National Park and Sawantwadi as Important Bird Areas (IBAs) and Sawantwadi, Lonavala, Amba, Amboli, and Chandgad for inclusion under Environmentally Sensitive Area, as unregulated commercial development is emerging as a major threat to these regions.

**Key words:** Maharashtra, Western Ghats, endemic birds, forest degradation, biotic pressure, bird protection

## INTRODUCTION

The Western Ghats region in India has been listed as one of the 34 Global Biodiversity Hotspots owing to its extraordinarily rich biodiversity (Myers 1990). The Western Ghats occupy 7% of India's land mass, of which only one-third is under forest cover and yet it supports 30% of the country's biodiversity, which makes it one of the high priority regions for conservation. Broadly, the Western Ghats are divided into two main regions: the northern Western Ghats, which lie in Gujarat, Maharashtra, Goa, and the northern districts of Karnataka, and the southern Western Ghats, which lie mainly in southern Karnataka, Tamil Nadu, and Kerala (Western Ghats Ecosystem Profile 2007).

Historically, the forests of Western Ghats were well-protected by local rulers and their inaccessibility prevented the people from cultivation and construction. By the 1890s, the forest administration was under British control and they introduced the system of reserving good quality forests, but soon began exploiting the timber for ship building and railways during the two World Wars. This exploitation continued in the post-independence era, leading to further fragmentation of forests in the Western Ghats (BVIIEER 2010; Daniels *et al.* 1990). In recent times, land use changes due to urbanisation, industrial and agricultural expansion, mining, road building, and hydroelectric projects have further intensified habitat loss in the Western Ghats. There has been a decrease of 610 sq. km (10.57%) in dense forest cover and

an increase of 346.9 sq. km (8.91%) in open forest cover from 1985–87 to 2005 (Panigrahy *et al.* 2010).

There are 58 Protected Areas (PAs) within the Western Ghats, and most of them are surrounded by human habitation. With a high density of 250 people/sq. km, anthropogenic pressures are escalating in the PAs and Reserve Forests (RFs). Recent analysis of threats in the Western Ghats region revealed that 90% of the PAs were facing local pressures, such as fuel wood collection, fodder removal and hunting; while landscape level pressures, such as mining, railways, and road building were relatively lower (Western Ghats Ecosystem Profile 2007).

Five hundred and twenty-eight bird species are recorded from the Western Ghats (Islam and Rahmani 2004). Of these 16 species are included in the Red Data List by the IUCN (BirdLife International 2010). To protect these birds and their ecosystems, BirdLife International has categorised regions having conservation-dependent endemic bird species as Endemic Bird Areas (EBAs). According to these criteria, Western Ghats is one of the important EBAs (Islam and Rahmani 2004; Stattersfield *et al.* 1998). While a few quantitative research studies on birds of southern Western Ghats exist (Daniels 1989; Daniels *et al.* 1990; Davidson 1989; Mudappa and Raman 2009; Raman 2001, 2006; Sidhu *et al.* 2010), the birds of the Western Ghats region of Maharashtra have been documented largely as descriptive natural history accounts (Betham 1902; Butler 1884; Fairbank 1876), in field guides (Pandey *et al.* 2003) or in sporadic observations (Abdulali 1965, 1981; Ali 1949, 1952; Ambedkar 1991;

Borges 1986; Monga and Rane 1986). The most comprehensive work has been done by Gole (1998) from 1994 to 1996, wherein he documented the presence of forest birds, including the endemics in the study area. More recently, Mudappa and Raman (2009) carried out an extensive survey on hornbills in the entire Western Ghats, including Maharashtra, with information on the presence of endemic birds of the region. However, a comprehensive field-based assessment of endemic birds from PAs and RFs of Western Ghats region of Maharashtra is absent. Such an assessment will help to designate areas that are valuable for bird conservation. The assessment is essential, given the rapid industrial and other developments that the Western Ghats region of Maharashtra currently face (BVIEER 2010; Panigrahy *et al.* 2010). Through this survey, we specifically seek to determine: a) areas that support endemic birds, b) major threats to the forests in this region, and c) areas important for long-term bird conservation.

#### Profile of Western Ghats region of Maharashtra

The Western Ghats region of Maharashtra extend from 15° 30' to 29° 30' N, and 72° 30' to 75° E in Western Maharashtra. They cover three distinct geographical regions. The Ghats region consists of mountain tops to the east of the Western Ghats crestline, ranging from 900 to 1,600 m above msl. Konkan is the western low-lying coastal region up to 400 m above msl. Mawal is the easternmost portion of the Ghats at 600 to 800 m above msl (Ghate 1993), and is the transition zone from the hills to the plains. From north to south there is a slight increase in rainfall. The Ghats region receives about 5,000 to 7,000 mm rainfall, whereas Konkan and Mawal record an average rainfall between 2,000 to 5,000 mm (Ghate *et al.* 1994). The Ghats region supports primarily evergreen forests. The region south of 19° N supports semi-evergreen forests, while the region to its north supports mainly deciduous forests. However, a few pristine pockets of evergreen forests still exist in Sawantwadi (16° N) and Phansad Sanctuary (18° N). At most places in the Western Ghats region of Maharashtra, evergreen forests exist as secondary forests mainly in the Ghats region, while in the foothills they are mostly semi-evergreen (Ghate *et al.* 1994). The surveyed sites are listed in Tables 1 and 2 and their locations are shown in Fig. 1.

Of the 16 endemic birds of the Western Ghats, eight species are confined to southern Western Ghats, while the remaining eight species are found in the entire length of the Western Ghats. These species are the Crimson-backed Sunbird *Leptocoma minima*, Malabar Parakeet *Psittacula columboides*, Malabar Grey Hornbill *Ocyeros griseus*, White-bellied Blue Flycatcher *Cyornis pallipes*, Indian



Fig. 1: Location Map of Surveyed Areas in Western Ghats of Maharashtra.

SGNP = Sanjay Gandhi National Park;

HKWLS = Harishchandrabad-Kalsubai Wildlife Sanctuary

Rufous Babbler *Turdoides subrufus*, White-checked Barbet *Megalaima viridis*, Malabar Lark *Galerida malabarica*, and Nilgiri Woodpigeon *Columba elphinstonii*. In addition, the area also supports other important species such as the Great Pied Hornbill *Buceros bicornis*, Malabar Pied Hornbill *Anthracceros coronatus*, Yellow-browed Bulbul *Iole indica*, Painted Bush-quail *Perdica erythrorhyncha*, Malabar Trogon *Harporhynchus fasciatus*, Malabar Whistling-thrush *Myophonus horsfieldii*, and White-browed Bulbul *Pycnonotus luteolus* (Gole 1998; Islam and Rahmani 2004). Isolated records of the Black-headed Babbler *Rhopocichla atriceps* from Koyna (by Shantaram as mentioned in Gole 1998) and Black Baza *Aviceda leuphotes* from Bhimashankar (Rane and Borges 1987) have been reported.

**Table 1:** Details of Protected Areas (PAs) surveyed

District	Name of PA	Location	Altitude (m above msl)	Vegetation Type
Ahmednagar	Harishchandrabad-Kalsubai WLS	19° 42' N, 73° 52' E	600–1,460	Moist deciduous, Semi-evergreen
Thane	Sanjay Gandhi National Park*	19° 18' N, 72° 57' E	up to 500	Moist deciduous, Semi-evergreen
Pune	Bhimashankar Sanctuary	19° 2' N, 73° 35' E	600–1,100	Moist deciduous, Semi-evergreen, Evergreen
Raigad	Phansad Sanctuary	18° 20' N, 72° 54' E	up to 500	Dry deciduous, Moist deciduous, Semi-evergreen
Sangli/Kolhapur	Chandoli National Park	17° 29' N, 73° 55' E	580–1,044	Semi-evergreen, Evergreen
Satara	Koyna Sanctuary	17° 38' N, 73° 45' E	500–1,100	Semi-evergreen, Evergreen
Kolhapur	Radhanagari Sanctuary	16° 22' N, 74° E	500–972	Semi-evergreen, Evergreen

\*Tungreshwar Wildlife Sanctuary has been included in SGNP

## Methodology

There are twelve districts in the Western Ghats of Maharashtra. The survey was carried out in eight districts in seven PAs and eleven RFs from 2007 to 2009. Since the study was designed as a multi-species avifaunal survey, we found the species richness measures to be most appropriate as it can generate an index of abundance of species as well as bird composition in an area. We used the MacKinnon's list method (MacKinnon and Phillips 1993) for the survey. This method is useful when the area to be surveyed is large and time period is short. It is also useful for comparing areas when the survey is conducted by multiple observers with different bird spotting and identification ability (Javed and Kaul 2002; O'Dea *et al.* 2004). MacKinnon's list method is a specific form of listing that records species on fixed-length lists rather than fixed-time lists. Thus, the area to be surveyed is sampled till first  $n$  species are encountered, where  $n$  is a fixed number (typically 10, 12, 15, or 20). The second list is started after completion of the first list and has the same fixed length. This process is repeated till the survey for an area is completed. The measure of effort is the number of lists. The length of a list is decided after a preliminary survey. Longer list size is selected in species-rich areas and shorter list size is selected in species-poor areas. Encounter of a species is recorded only once in a list even if it occurs multiple times. A repeat encounter in the

same list does not add to number of species but to number of individuals encountered in the list. Commonly encountered species appear on multiple lists, while less common species appear in fewer lists. The number of individuals encountered can be recorded as a measure of the abundance of a species. To compare species richness between sites, cumulative numbers of species discovered are recorded over successive lists. Sites with higher species-discovery rates have higher richness than those with lower species-discovery rates.

We carried out preliminary trials whereby we concluded that a list of 12 species can be completed in a reasonably short period of time and a full day's survey can yield about 6 to 8 lists. On this basis we selected 12 bird species as the length of one list for this survey. In most sites we spent 2 to 4 days to survey different habitats for recording bird species. Each site was surveyed once during the same season. The survey being in a large geographic area, seasonal visits were not possible. The following information was recorded for each list: latitude and longitude, altitude, length of the trail, species and number of birds seen. Additionally, habitat parameters such as forest type, terrain, dominant trees and shrubs of the area, and average tree height were also noted.

To assess the status of endemic and other important birds, encounter rates were generated by calculating number of detections of endemic and important species per kilometre

**Table 2:** Details of Reserve Forests (RFs) surveyed

District	Name of RF	Location	Altitude (m above msl)	Vegetation Type
Pune	Mulshi	18° 44' N, 73° 40' E	600	Semi-evergreen
	Rareshwar	18° 25' N, 73° 53' E	700–1,350	Semi-evergreen, Grassland
	Lonavala & INS Shivaji	18° 46' N, 73° 24' E	up to 1,100	Moist deciduous, Semi-evergreen, Evergreen
	Sinhagad	18° 37' N, 73° 77' E	600–800	Moist deciduous
Satara	Mahabaleshwar	17° 52' N, 73° 39' E	1200–1,400	Semi-evergreen
Kolhapur	Amba	16° 58' N, 73° 47' E	1200–1,400	Semi-evergreen, Evergreen
	Sindhudurg	Ambohi	15° 57' N, 73° 59' E	700–800
Kolhapur	Sawantwadi	15° 54' N, 73° 48' E	50–200	Semi-evergreen, evergreen, Moist deciduous
	Chandgad	15° 50' N, 74° 8' E	up to 500	Semi-evergreen
	Kasarsada	15° 55' N, 74° 16' E	1,000	Semi-evergreen
	Durgmanwadi	16° 45' N, 73° 9' E	500–980	Semi-evergreen

Table 3: Encounter rate of endemic birds in Protected Areas

Endemic Species	HKWLS	SGNP	Bhimashankar	Phansad	Koyna	Chandoli	Radhanagari
Crimson-backed Sunbird	0.4 (±0.12)	0.08 (±0.08)	0.25 (±0.07)	0.03 (±0.03)	0.86 (±0.16)	0.62 (±0.35)	0.33 (±0.09)
Malabar Grey Hornbill	-	-	-	0.03 (±0.03)	0.05 (±0.05)	0.19 (±0.19)	-
Malabar Parakeet	-	-	-	-	0.12 (±0.11)	0.09 (±0.09)	-
Malabar Lark	0.25 (±0.11)	-	0.04 (±0.04)	-	0.07 (±0.05)	0.19 (±0.12)	-
Nilgiri Woodpigeon	-	-	0.04 (±0.04)	0.03 (±0.03)	0.06 (±0.06)	0.09 (±0.09)	-
Indian Rufous Babbler	-	-	-	-	-	-	-
White-cheeked Barbet	0.04 (±0.02)	-	-	-	0.13 (±0.09)	0.23 (±0.15)	-
White-bellied Blue Flycatcher	0.11 (±0.09)	-	0.07 (±0.03)	-	0.19 (±0.08)	0.09 (±0.09)	-

HKWLS = Harishchandragad-Kalsubai Wildlife Sanctuary, SGNP = Sanjay Gandhi National Park

Figures in parentheses indicate standard error

travelled in the surveyed sites. To compare the relative abundance of an endemic species, we compared the encounter rate of the same species across the sites. An assessment of impact of anthropogenic pressures on the birds was carried out in four broad categories, namely presence of development projects in the area (windmills, mines, roads, railway, dams), anthropogenic pressure from local communities (encroachment on forest land, collection of firewood for commercial sale, logging, livestock grazing), tourism, and hunting (hunting for meat or trade). This information was collected for each site by holding discussions with local people and forest staff, and by field observations. The severity of threat in each category was recorded as low, medium, or high, based on subjective assessment of the observer.

## RESULTS

### New Records

Our survey yielded two new records of birds from the Western Ghats of Maharashtra. The Grey-headed Fish-Eagle *Ichthyophaga ichthyaeus* (Horsfield 1821) was recorded near Chandoli Reservoir (17° 29' N; 73° 55' E). In Maharashtra, this species has been recorded from Tadoba Tiger Reserve (Naoroji 2006) but there is no published record from Western Maharashtra. The other new record was that of the Black-crested Bulbul *Pycnonotus melanicterus gularis*. Two individuals were seen in semi-evergreen forests surrounding a cliff at 629 m

above msl near Amba Reserve Forest (16° 94' N; 74° E). Three more individuals were seen at Talkat Reserve Forest (15° 48' N; 73° 57' E) near evergreen forests along the roadside at 128 m above msl. The crestless race *P. m. gularis* of the Western Ghats has earlier been recorded from Goa southwards till Kerala and Tamil Nadu (Ali and Ripley 1987; Grimmett *et al.* 1999; Rasmussen and Anderton 2005).

### Bird Species Richness

A total of 224 bird species from 48 families were identified during the survey. Species richness curves were plotted for PAs and RFs and are given in Figs 2 and 3 respectively. Since different sites have a different number of lists, only the first 10 lists were plotted for all the sites. Since the random nature of species discovery can make comparisons difficult, the data was first smoothed by carrying out 100 randomisations before plotting. The randomisation process yields fractional numbers of species which were rounded off to the nearest integer. The sites with highest species-discovery rates have the highest species richness and those with lowest discovery rates have the lowest richness. Among PAs, Chandoli and Phansad have the highest richness, followed by Sanjay Gandhi National Park (SGNP), Bhimashankar and Koyna. Harishchandragad-Kalsubai Wildlife Sanctuary (HKWLS) has the lowest species richness, which was expected, as the northern sites are generally thought to have lower richness and also because the forests of HKWLS

Table 4: Encounter rates of other important species in Protected Areas

Species	HKWLS	SGNP	Bhimashankar	Phansad	Koyna	Chandoli	Radhanagari
Great Pied Hornbill	-	-	-	-	-	-	-
Malabar Pied Hornbill	-	-	-	0.09 (±0.09)	-	0.08 (±0.08)	-
Yellow-browed Bulbul	0.09 (±0.08)	-	0.12 (±0.06)	-	0.67 (±0.14)	-	0.22 (±0.08)
Malabar Whistling-thrush	-	-	0.01 (±0.01)	-	-	-	-

HKWLS = Harishchandragad-Kalsubai Wildlife Sanctuary, SGNP = Sanjay Gandhi National Park

Figures in parentheses indicate standard error



Table 5: Encounter rate of endemic birds in Reserve Forests

Endemic Species	L'via	M'shi	M'war	R'war	C'gad	S'gad	DMW	KSD	Amba	Amboli	S'wadi
Crimson-backed Sunbird	0.05 (±0.06)	0.57 (±0.25)	-	0.13 (±0.15)	-	-	0.36 (±0.05)	0.91 (±0.06)	0.21 (±0.21)	0.92 (±0.26)	-
Malabar Grey Hornbill	-	-	-	-	0.11 (±0.19)	-	-	-	0.12 (±0.12)	0.12 (±0.21)	1.09 (±0.77)
Malabar Parakeet	-	-	-	-	-	-	-	-	-	-	-
Nilgiri Woodpigeon	-	-	-	-	0.27 (±0.17)	-	-	-	-	0.60 (±0.38)	-
Malabar Lark	0.10 (±0.07)	-	0.2 (±0.12)	0.17 (±0.12)	-	-	0.51 (±0.10)	-	-	-	-
Indian Rufous Babbler	-	-	-	-	-	-	-	0.01 (±0.01)	-	-	-
White-bellied Blue Flycatcher	-	0.12 (±0.24)	0.06 (±0.18)	-	0.16 (±0.19)	0.50 (±0.00)	-	0.23 (±0.26)	0.14 (±0.14)	-	0.35 (±0.25)
White-cheeked Barbet	0.14 (±0.10)	0.13 (±0.13)	0.06 (±0.06)	-	-	-	-	0.28 (±0.22)	0.33 (±0.24)	0.48 (±0.38)	-

L'via = Lonavala, M'shi = Muishi, M'war = Mahabaleshwar, R'war = Rareshwar, DMW = Durgmanwadi, KSD = Kasarsada, C'gad = Chandgad, S'gad = Sinhadgad, S'wadi = Sawantwadi. Figures in parentheses indicate standard error

Table 6: Encounter rates of other important species in Reserve Forests

Species	L'via	M'shi	M'war	R'war	C'gad	S'gad	DMW	KSD	Amba	Amboli	S'wadi
Great Pied Hornbill	-	-	-	-	0.21 (±0.26)	-	-	-	0.22 (±0.15)	-	0.61 (±0.43)
Malabar Pied Hornbill	-	-	-	-	0.06 (±0.27)	-	-	-	-	-	-
Yellow-browed Bulbul	-	0.53 (±0.39)	-	-	0.64 (±0.22)	0.12 (±0.69)	0.15 (±0.15)	0.69 (±0.27)	0.14 (±0.12)	0.80 (±0.31)	0.05 (±0.04)
Malabar Whistling-thrush	-	-	0.06 (±0.06)	-	0.10 (±0.13)	-	-	-	0.14 (±0.14)	0.08 (±0.09)	-

L'via = Lonavala, M'shi = Muishi, M'war = Mahabaleshwar, R'war = Rareshwar, DMW = Durgmanwadi, KSD = Kasarsada, C'gad = Chandgad, S'gad = Sinhadgad, S'wadi = Sawantwadi. Figures in parentheses indicate standard error

**Table 7:** Total (endemic and other important) bird species recorded from Protected Areas

Species	HKWLS	SGNP	Bhimashankar	Phansad	Koyna	Chandoli	R'nagari
Endemic	4	2	4	3	7	8	7
Others	1	-	2	1	3	3	3
<b>Total</b>	<b>5</b>	<b>2</b>	<b>6</b>	<b>4</b>	<b>10</b>	<b>11</b>	<b>10</b>

HKWLS = Harishchandragad-Katsubai Wildlife Sanctuary, SGNP = Sanjay Gandhi National Park, R'nagari = Radhanagari

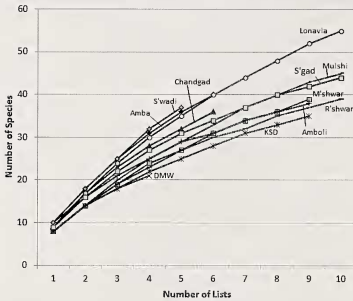


Fig. 2: Species richness curves for Protected Areas

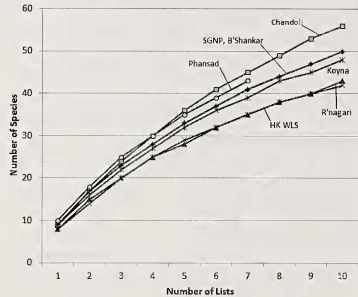


Fig. 3: Species richness curves for Reserve Forests

are highly fragmented. The low richness of Radhanagari is probably an anomalous result, which is explained in a section below.

Among RFs, Sawantwadi, Lonavala, and Amba have the highest richness. Chandoli, Sinhadag, and Mulshi have intermediate richness. The high altitude plateaux Mahabaleshwar and Rareshwar have low richness. Small sites such as Durgmanwadi (DMW) and Kasarsada (KSD) have very low richness. The high richness of Lonavala is unexpected because it is a northern site lacking in endemic species. A possible explanation for this is a varied habitat due to presence of deep valleys.

**Encounter Rate of Endemic and other Important Bird Species**

Among the endemic species, the Crimson-backed Sunbird was most widely distributed around edges, secondary forests, and plantations. The White-bellied Blue Flycatcher, a forest-dependent species, was encountered frequently along streams, waterholes, and riparian areas from many PAs and RFs. The Malabar Grey Hornbill was recorded from undisturbed semi-evergreen forests of PAs and RFs that were south of 16° N. We saw large flocks of Malabar Parakeet only in the PAs Radhanagari, Koyna, and Chandoli. There is a report of this species from INS Shivaji in Lonavala (Islam

**Table 8:** Total (endemic and other important) bird species recorded from Reserve Forests

Species	L'vla	M'shi	M'war	R'war	C'gad	S'gad	DMW	KSD	Amba	Amboli	S'wadi
Endemic	8	3	3	2	3	1	2	4	4	4	3
Others	3	2	2	-	4	-	1	1	3	3	3
<b>Total</b>	<b>11</b>	<b>5</b>	<b>5</b>	<b>2</b>	<b>7</b>	<b>1</b>	<b>3</b>	<b>5</b>	<b>7</b>	<b>7</b>	<b>6</b>

L'vla = Lonavala, M'shi = Mulshi, M'war = Mahabaleshwar, R'war = Rareshwar, DMW = Durgmanwadi, KSD = Kasarsada, C'gad = Chandoli, S'gad = Sinhadag, S'wadi = Sawantwadi

Table 9: Threat scores in Protected Areas

Sites	Development Projects	Encroachment	Biotic Pressure	Tourism	Poaching Hunting
SGNP	Medium	High	Medium	High	Medium
H'gad	High	-	High	High	High
Bhimashankar	High	Medium	High	Very High	High
Phansad	-	-	Medium	Low	Low
Koyna	Low	-	Low	Low	Low
Chandoli	Low	-	Low	Low	Low
Radhanagari	Medium	-	Medium	Low	Low

^ indicates not observed or reported; SGNP=Sanjay Gandhi National Park; H'gad=Harishchandrabad

and Rahmani 2004). The Nilgiri Woodpigeon, the only vulnerable endemic of this region, was recorded in thickly wooded habitats and undisturbed riparian habitats of PAs. There are very few records of the Indian Rufous Babbler from the Western Ghats region of Maharashtra. It inhabits the understorey of moderately thick forests and secondary forest areas. We recorded the species from Kasarsada RF (Table 5).

The Great Pied Hornbill and Malabar Pied Hornbill are in the Near Threatened category and Schedule I species of the Wildlife (Protection) Act, 1972. We encountered both species from private forests and RFs of Chandgad, Amboli and Sawantwadi. The Malabar Pied Hornbill was recorded south of 17° N near secondary forests and fields. The Yellow-browed Bulbul was encountered from all areas between 16° N to 19° N. The Malabar Whistling-thrush was mainly encountered from PAs and RFs south of 17° N. We did not encounter the Black-headed Babbler and Painted Bush-quail from the surveyed sites. Both the species are skulkers and could have been missed.

Tables 7 and 8 summarise the occurrence records of endemic and other important species from PAs and RFs in the northern Western Ghats. For the sake of completeness, we have included records from recent reports by Gole (1998),

and Mudappa and Raman (2009) as they refer to the same study area. The results indicate that among the PAs, Chandoli, Koyna, and Radhanagari support the maximum number of endemic birds, while among RFs, Amba, Amboli, Chandgad, and Sawantwadi have the maximum number of endemic birds. All these sites are located south of 18° N.

#### Records of Uncommon Bird Species

During the survey, we recorded a few species not commonly reported from the Western Ghats region of Maharashtra. Amur Falcon *Falco amurensis*, a passage migrant, was recorded from Harishchandrabad Kalsubai Sanctuary and the Japanese Buzzard *Buteo buteo japonicus* was seen at Radhanagari. The Black-naped Oriole *Oriolus chinensis* has patchy and uncertain distribution within the country (Rasmussen and Anderton 2005). Butler (1884) recorded it from Ratnagiri. We saw eight individuals at SGNP and Tungreshwar Sanctuary. The Brown-breasted Flycatcher *Muscicapa muttui*, a species of evergreen forests of southern Western Ghats, was recorded from Koyna during the survey. There are old records of Asian Fairy Bluebird *Irena puella* from Ratnagiri and Mahabaleshwar (Ali and Ripley 1987). We recorded five individuals of Fairy Bluebird from the RFs of

Table 10: Threat scores in Reserve Forests

Sites	Development Projects	Encroachment	Biotic Pressure	Tourism	Poaching Hunting
Lonavala	High	Low	High	High	High
Mulshi	High	Low	High	High	High
Mahabaleshwar	High	Low	High	High	Low
Rareshwar	Medium	-	Medium	Low	-
Sinhagad	Medium	Low	High	High	Low
Durgmanwadi	High	-	Very High	-	High
Kasarsada	High	-	Medium	-	Medium
Chandgad	Low	Low	Medium	-	Medium
Amba	High	-	High	High	-
Amboli	High	-	Medium	High	Medium
Sawantwadi	High	Low	High	Medium	Medium

^ indicates not observed/reported

Sawantwadi. Jerdon's Nightjar *Caprimulgus atripennis* was recorded from Phansad and Koyna Sanctuaries. Besra Sparrowhawk *Accipiter virgatus* is not recorded commonly from the northern Western Ghats. We recorded the species from Bhimashankar Sanctuary, HKWLS, and Kasarsada. Although we could not locate the Sri Lankan Frogmouth *Batrachostomus moniliger*, there are confirmed records of its presence from Chandoli, Phansad, and Amboli (Varad Giri, pers. comm.). We had frequent sightings of the Blue-bearded Bee-eater *Nyctornis aethiopi* from Chandgad and Kasarsada RF.

#### Anthropogenic Pressures inside Protected Areas

Tables 9 and 10 describe the types and severity of anthropogenic pressures in the surveyed areas. Recently, windmills have been set up on the southern boundary of Bhimashankar and the construction of an approach road to the windmill site has resulted in felling of a large number of trees in the area (Madhav Gadgil, pers. comm.). The construction of a state highway from Ale Phata to Murbad, which borders the southern boundary of HKWLS has resulted in degradation of Malshej Ghat forests of the Sanctuary – a corridor between HKWLS and Bhimashankar. In Chandoli, an active bauxite mine on the southern boundary of the sanctuary is the main commercial project in the area. Throughout the day, trucks with bauxite travel up and down the Udgiri-Gothne road, causing immense air and noise pollution. The forests surrounding Gothne appear degraded and disturbed due to mining activity. Anthropogenic pressures from local communities in terms of livestock grazing and firewood collection were high mainly in HKWLS and Bhimashankar. In Bhimashankar, the local villagers have started to sell firewood and stems of *Thelepaepale isocephala* (Wayti in the local language) for raising tomato crops in the plains. This has created a lot of disturbance to the sanctuary vegetation. In Bhimashankar, temple tourism is a serious problem because a large number of people camp and cook inside the forest, which results in disturbance and pollution. Hunting of birds for meat was observed from most PAS. The Katkari and Thakar communities of Bhimashankar and HKWLS are habituated to hunting birds and animals. We recorded many traps for junglefowl, hare, sambar, and mouse deer in Bhimashankar. In Harishchandragad, young boys from Ratanwadi and Thakkarwadi roam the whole day with catapults, hunting many species of birds. However, Chandoli, Koyna, and Radhanagari are relatively well-protected and do not have serious threats to the habitat.

#### Anthropogenic Pressures in Reserve Forests

The major threat to forests in Lonavala, Amba, Mulshi, and Sawantwadi is from commercial resorts that have been

built by clearing native forests. In Tamhini, there is a breeding colony of Long-billed Vulture and a probable nesting site of Great Pied Hornbill. However, this area has become overcrowded due to tourism, which has disturbed the tranquil habitats of Mulshi and Tamhini region. The Hirpude and Velhe habitats near Rareshwar are degraded due to intense grazing pressure. On the Rareshwar plateau, people come to collect grass and medicinal plants, which causes serious disturbance to ground birds. Sawantwadi forests have an interspersed landscape of agriculture, private forests, and reserve forests. The private forests that are frequented by Great Pied Hornbill and Black Eagle (this survey) are now fast disappearing, as many of them are being converted to coconut, areca nut and oil palm plantations. If this trend continues, the Sawantwadi region will have no natural habitat left for hornbills.

#### DISCUSSION

With human pressure on land rising, many ecologically rich areas are under serious threat of possible extinction of species. Under the circumstances, it has become imperative for conservationists to identify and prioritise sites that require immediate conservation action in order to protect their uniqueness in terms of the species, habitat, or the ecosystem services they support. The biodiversity hotspot approach (Myers 1990), using the presence of endemic species, has become a globally accepted procedure for identifying priority areas for conservation action, as it helps in defining investment priorities at the regional scale (Myers *et al.* 2000; Turner *et al.* 2007). Being in the forefront of the entire Western Ghats, the Western Ghats region of Maharashtra are vital to zoogeography considerations. From 1987 to 2005, a marked decrease (0.79%) of dense forest and increase (0.45%) of open forest has been reported from Western Ghats region of Maharashtra, indicating severe anthropogenic pressures on the habitat (Panigrahy *et al.* 2010). Using the presence of endemic and other important birds, we highlight the importance of protecting the forests for bird conservation in Western Ghats region of Maharashtra.

#### Impact of Habitat on Species Richness

Chandoli, Koyna, and Bhimashankar had higher richness as these areas have many patches of undisturbed and mature forests and are also larger than the isolated areas of SGNP and Phansad. Bird species richness is known to be associated with the size of the forest patch, composition and structure of the forests, availability of contiguous forest areas, and proximity to well-wooded, undisturbed forested areas (Ambuel and Temple 1983; Mehta 1998; Raman 2006). The most anomalous result was the low ranking of Radhanagari

**Table 11:** Scores for ecological richness and threat factors of Protected Areas

Site	Score for Species Richness	Score for Endemic Species	Score for Other Species	Score for Threats	Total Score
HKWLS	2.3	1.5	0.8	3	7.6
SGNP	2.7	0.8	0.0	3	6.5
Bhimashankar	2.7	1.5	1.5	3	8.7
Phansad	2.7	1.1	0.8	1	5.6
Koyna	2.6	2.6	2.3	1	8.5
Chandoli	3.0	3.0	2.3	1	9.3
Rdhanagari	2.3	2.6	2.3	1	8.2

HKWLS=Harishchandragad-Kalsubai Wildlife Sanctuary;  
SGNP=Sanjay Gandhi National Park

Sanctuary. A possible explanation is that the survey was carried out in limited habitats due to logistic constraints, therefore the number of species recorded was low. Lonavala recorded the highest bird species richness among the RFs. Lonavala, while having some patches with good vegetation, is a relatively fragmented area, interspersed with agricultural areas and human habitations. Generalist species and waterbodies could have added to the species list for this site and increased the species richness. Bird richness was high in Sawantwadi in the Konkan zone and Amba in the Ghat zone because these sites have many undisturbed patches of valley and riparian forests that may have contributed to species richness. Mahabaleshwar Plateau has stunted trees and relatively uniform vegetation, which does not support a diverse birdlife. Kasarsada, Durgmanwadi, and Rareshwar have smaller forest fragments, therefore the species richness was also lower.

#### Distribution of Endemic Birds in the Western Ghats region of Maharashtra

Among the endemics, the Crimson-backed Sunbird, White-cheeked Barbet, White-bellied Blue Flycatcher, and the Malabar Lark were widely distributed in the survey area. The first three species were recorded from 15° to 19° N, from dry deciduous to riparian forests; the Malabar Lark was recorded from grasslands. Previous records by Fairbank (1876), Gole (1998), and Mudappa and Raman (2009) also report these species to be frequently encountered in the region. Fairbank (1876) reported Malabar Parakeet to be common in Khandala (18° N), but recent reports (Gole 1998; Mudappa and Raman 2009; this survey) report them south of 16° N only. Although the Nilgiri Woodpigeon is often seen in secondary forests feeding on fruiting trees (Authors, pers. obs.), it has been recorded mainly from riparian and undisturbed semi-evergreen forests in Western Ghats region

**Table 12:** Scores for ecological richness and threat factors of Reserve Forests

Site	Score for Species Richness	Score for Endemic Species	Score for Other Species	Score for Threats	Total Score
Lonavala	2.9	3	2.3	3	11.2
Mulshi	2.4	1.1	1.5	3	8
Sinhagad	2.3	0.4	-	2	4.7
Rareshwar	2.1	0.8	-	2	4.9
Mahabaleshwar	2.1	1.1	1.5	3	7.7
Amba	2.7	1.5	2.3	3	9.5
DMW	1.8	0.8	0.8	2	5.4
Amboli	2.1	1.5	2.3	3	8.9
Kasarsada	1.9	1.5	0.8	2	6.2
Sawantwadi	3	1.1	2.3	3	9.4
Chandgad	2.5	1.1	3	3	9.6

DMW=Durgmanwadi

of Maharashtra (Mudappa and Raman 2009; this survey). There are very few records of the Indian Rufous Babbler from this region. It inhabits the understorey of moderately thick forests and secondary forest areas. We recorded the species from Kasarsada RF. This babbler has been reported to be sparsely distributed south of Mahabaleshwar (Gole 1998) and near Amboli RF (Mudappa and Raman 2009). More information is required on its distribution. Earlier surveys (Butler 1884; Fairbank 1876) indicate the occurrence of Great Pied Hornbill, Malabar Grey Hornbill, and Malabar Pied Hornbill from the northern regions till Khandala and Mumbai, but recent surveys (Gole 1998; Mudappa and Raman 2009; this survey) have recorded these species mainly from south of Satara district (16° N). Butler (1884) reported the Malabar Whistling-thrush as common throughout the region, while Gole (1998) reported it as rare in the Western Ghats region of Maharashtra. This survey found it to be uncommon, but not rare.

From the above discussion it appears that forests north of 16° N earlier had suitable habitats for endemic species and hornbills, but in recent times, these habitats have been lost. This is corroborated by Panigrahy *et al.* (2010) who reported highest decrease in forest cover from Thane (29.29%), Nashik (25.25%), and Ratnagiri (16.45%), by comparison of vegetation imageries of 1985 with those of 2005. The decrease in the area of dense forest and increase in open forest and scrublands indicates pressures on the core forested areas. The significant increase in waterbodies is a response to the growing needs of agriculture, industry, and urbanisation. These changes have implications for the presence of endemic species in Western Ghats region of Maharashtra.



### Prioritisation of Sites for Bird Conservation in the Western Ghats region of Maharashtra

To assess which areas possess higher ecological values in Western Ghats region of Maharashtra, we carried out a comparative analysis by attributing scores to species richness, number of endemic and important birds recorded in the area. A score was also given for threat level for sites to indicate the urgency for taking action. Values of all ecological parameters were normalised to a maximum of 3. We totalled the scores of ecological values and threats in PAs and RFs to give an overall score out of a maximum possible score of 12 to assess the top ranking sites (Tables 11 and 12).

Sites with higher overall scores had high conservation priority. Among PAs, the conservation priority scores were highest for Chandoli, Bhimashankar, Koyna and Radhanagari, in that order. The high priority for Bhimashankar was partly due to the perceived high level of threat. Among RFs, the conservation priority scores were highest for Lonavala, Amba, Sawantwadi, Amboli, Chandgad, and Mulshi in that order. Lonavala had an exceptionally high score for conservation priority. This was because it scored high for presence of endemic and other important species, and had a high threat score. Mahabaleshwar, though declared an ecologically sensitive area, scored lower than other sites, such as Mulshi and Chandgad, because it had low scores for endemic species and other important species.

Those sites with high ecological threats and low human dependencies are classified as protection-dependent, meaning that efforts need to be directed towards their protection. This category includes the PAs Koyna, Chandoli, Radhanagari, Phansad, and SGNP. SGNP, though having high threat level was classified as protection-dependent because the threats are less due to human dependencies and more due to urban developmental pressures from Mumbai. Protection-dependent sites need Forest Department protection mechanisms to be strengthened. Sites with high human dependencies were classified as conservation-dependent sites, meaning that the people's dependencies need to be addressed and made sustainable. This category includes the PAs Bhimashankar and HKWLS, and all RFs. The actions recommended for these sites include initiating compatible land-use practices that will reduce the pressures of local villagers, along with education and awareness for protection of the habitat.

The inclusion of Chandoli NP and Koyna Sanctuary in Sahyadri Tiger Reserve is a good strategy to protect this entire landscape. Koyna has already been declared an Important Bird Area. We recorded eight endemic species, three important species (Table 9), and one new record from Western Ghats region of Maharashtra (Grey-headed Fish-Eagle) from Chandoli. Hence, we suggest inclusion of Chandoli under

the IBA programme.

Many RFs scored high on ecological values, but they also scored high on threat levels. Many RF areas are under pressure due to tourism infrastructure and developmental projects and urbanisation. Therefore, we suggest all the RFs be included in the conservation-dependent category. The role of RFs is vital in ensuring corridors between protected areas and safeguarding the environment. The Environment (Protection) Act, 1986 (EPA) is an official legislation constituted to regulate environment degradation and pollution. Under the EPA, an area can be declared as an Ecologically Sensitive Area (ESA) if it supports endemic or rare species, rare habitats, or geomorphic formations (Kapoor *et al.* 2009). A good way to protect them from further commercial exploitation would be to declare them as ESAs. Mahabaleshwar is already a declared ESA. Based on the results of our survey we recommend that Amba, Lonavala, Mulshi, Amboli, and Sawantwadi RFs be considered for declaration as ESAs since these areas have extensive forests rich in bird species with presence of several endemic birds. Lonavala scored the highest (11.2) in terms of conservation priority. Lonavala has been declared as an EBA, IBA, and Important Plant Area (Islam and Rahmani 2004). However, the process of urbanisation at Lonavala continues unabated. The Forest Department should make use of provisions such as IBA and ESA regulations to curb further commercial development in Lonavala.

Although the forests of Amboli-Sawantwadi region are fragmented and under pressure from commercial development, the bird species richness is high at these sites. A possible explanation is overall contiguity of the landscape and proximity to undisturbed forests of northern Goa and Karnataka. The low-altitude forests in the Konkan zone also tend to be taller, have more structural and species diversity compared to the forests in the Ghats zone, further contributing to bird diversity. Ghate *et al.* (1994) has mentioned that vegetation in Amboli-Sawantwadi region is more similar to southern Western Ghats and therefore the faunal composition also may be similar to that region. As mentioned earlier, species like the Malabar Trogon, Asian Fairy-Bluebird, Black-crested Bulbul, Brown-breasted Flycatcher, and Blue-bearded Bee-eater were not recorded north of Satara district. Bhimashankar, SGNP, Koyna, and Radhanagari Sanctuary, and Lonavala are already IBA sites. We suggest that Sawantwadi region be considered for inclusion under the IBA programme. Sinhadgad also has good potential for supporting higher numbers of forest species and should be taken up for conservation action at the earliest. Rareshwar is an important high altitude plateau, but is in an advanced state of neglect. The Forest Department needs

to take up intensive protection of the Rareshwar landscape. Generally, in RFs, conservation through community participation, monitoring land-use, protection of private forests, and regulation of commercial development and tourism are necessary for long-term conservation of birds in Western Ghats region of Maharashtra.

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